IMPROVED BIO-OILS FROM IN SITU CO-PYROLYSIS OF GRAPE SEEDS AND POLYSTYRENE

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ABSTRACT

The effective use of renewable sources to produce energy is an important objective to reduce the environmental impact caused by the exploitation of fossil fuels. The use of lignocellulosic biomass becomes one of the most promising alternatives, as it is the only renewable source of carbon that can produce products similar to fossil fuels through the pyrolysis process and does not compete with the food market. Unfortunately, the properties of pyrolytic bio-oils as fuels are very poor and different improvement strategies need to be implemented. Among all the strategies, co-pyrolysis of biomass and plastic waste such as polystyrene (PS), emerges as a promising way to achieve this goal. For synergistic reasons these raw materials are processed by co-pyrolysis giving the process the possibility to achieve this objective economically.

MAIN OBJECTIVE

The present work develops a new and low-cost strategy based on the in situ co-pyrolysis of biomass and plastic wastes that allows the user to obtain an advanced bio-oil to be used directly or to be processed in bio-refineries. The implementation of new, simple and low-cost strategy through co-pyrolysis of grape seeds and PS in a specifically designed fixed-bed reactor, that allows the user to directly obtain high quality bio-oils to be used as renewable energetic vector.

FEEDSTOCK AND CATALYST

Table 1. Feedstock (grapes seeds and polystyrene) characterisation

	GS	PS
Ash	4.6	0.1
Volatile matter	69.5	97.7
Fixed carbon	25.9	0.5
Ultimate analysis (wt.%)	**GS**	**PS**
C	57.6	90.3
H	6.3	9.1
N	2.4	0.3
S	0.2	0.0
O (by difference)	33.7	0.3
LHV (MJ/Kg)	22.2	42.1

Grape Seeds (GS)

Polystyrene (PS)

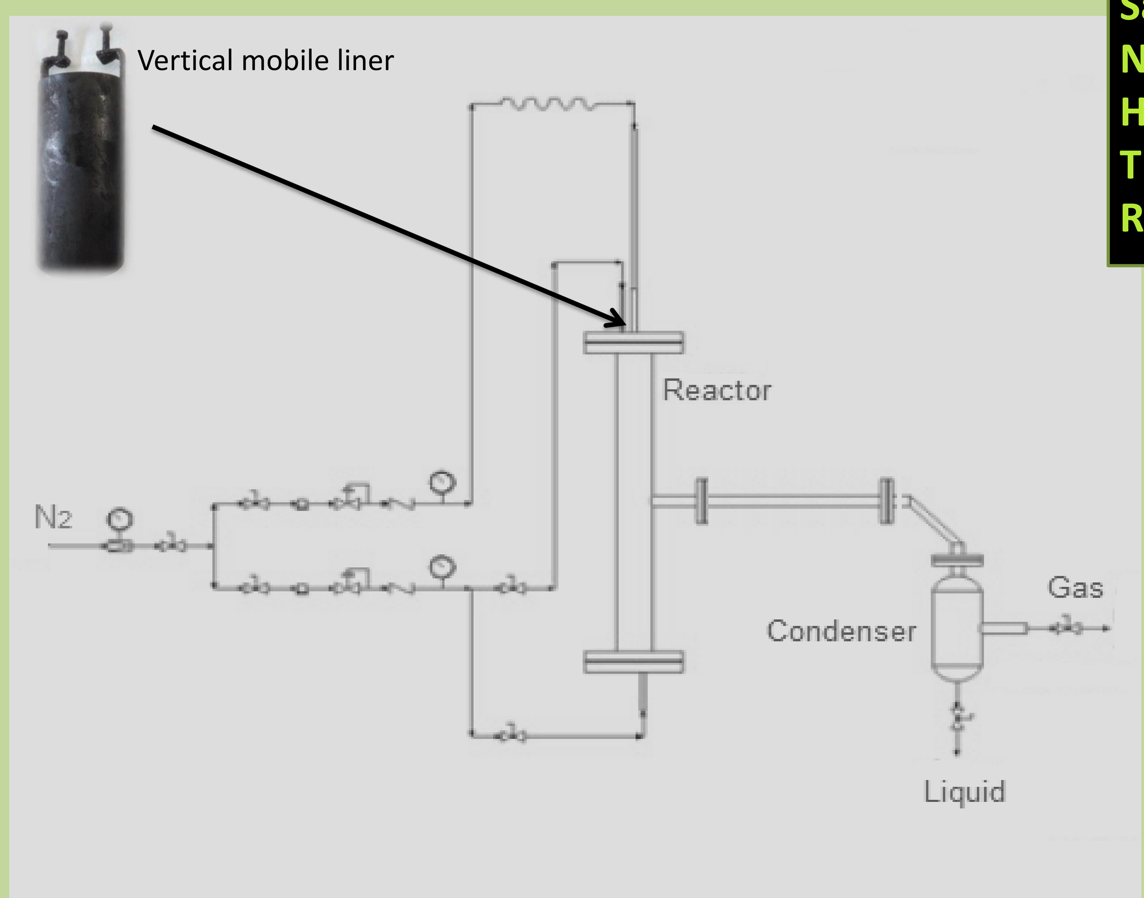
Different proportions of GS/PS in wt % were studied: 95/5; 90/10; 80/20; 60/40

EXPERIMENTAL

FIXED-BED REACTOR

Stainless steel fixed bed reactor (52.5 cm length and 5 cm internal diameter). This reactor has designed specifically to carry out this process having the peculiarity incorporate a vertical mobile liner, where feedstock is deposited, A condenser (ice-cooled trap) using a water reflux at 3ºC was used to collect the gas condensable fraction

Samples: 50 g
N_2 as carrier gas (300 ml/min)
Heating rate: 100 ºC/min
T Pyrolysis: 550 ºC
Reaction time: 30 min



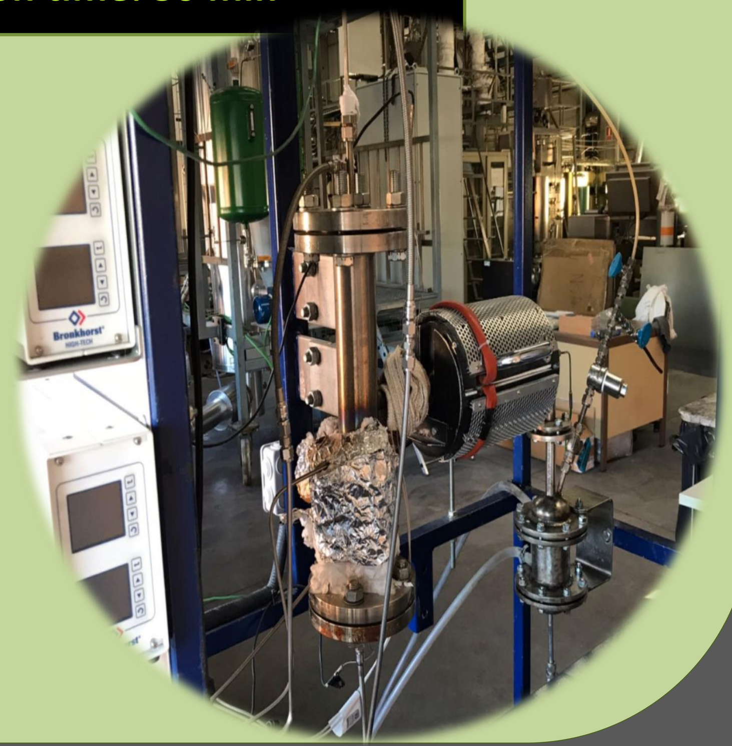


Figure 1. Fixed-bed reactor

RESULTS

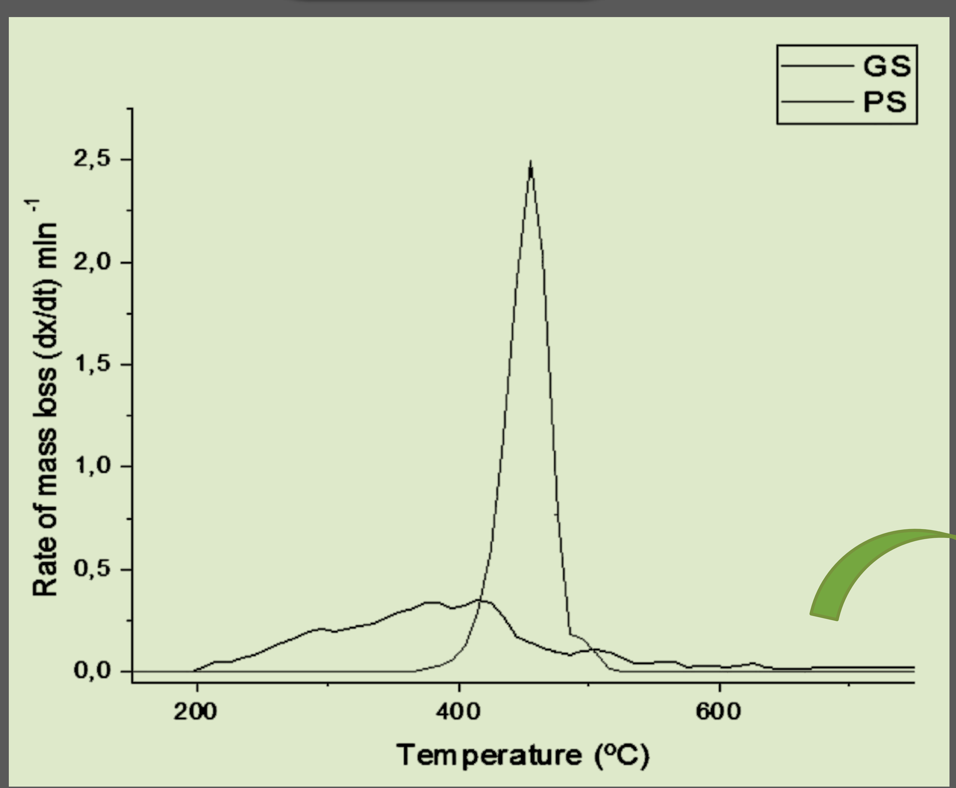


Figure 2. TGA analysis at 100ºC/min

Co-pyrolysis

Devolatilisation of both feedstock takes place at the same range of temperature

Section	Experiment	Liquid			Solid	Gas
		Total	Org.	Aq.		
Conventional pyrolysis	GS	38.8	61.1	38.9	33.4	23.9
	PS	82.0	100.0	0.0	1.0	14.3
Co-pyrolysis of GS and PS (Theoretical values in brackets)	95GS/5PS	39.8 (41.0)	73.8 (63.0)	26.2 (37.0)	31.2 (31.8)	26.0 (23.4)
	90GS/10PS	41.5 (43.1)	76.2 (65.0)	23.8 (35.0)	31.0 (30.2)	25.2 (22.9)
	80GS/20PS	50.6 (47.4)	80.2 (68.9)	19.8 (31.1)	27.4 (26.9)	20.1 (22.0)
	60GS/40PS	61.9 (56.1)	85.9 (76.7)	14.1 (23.3)	20.8 (20.4)	14.5 (20.1)

Table 2. Product yields in wt. % after conventional pyrolysis of GS and PS, co-pyrolysis of GS and PS

Two well-defined layers are obtained, allowing for an easy phase separation

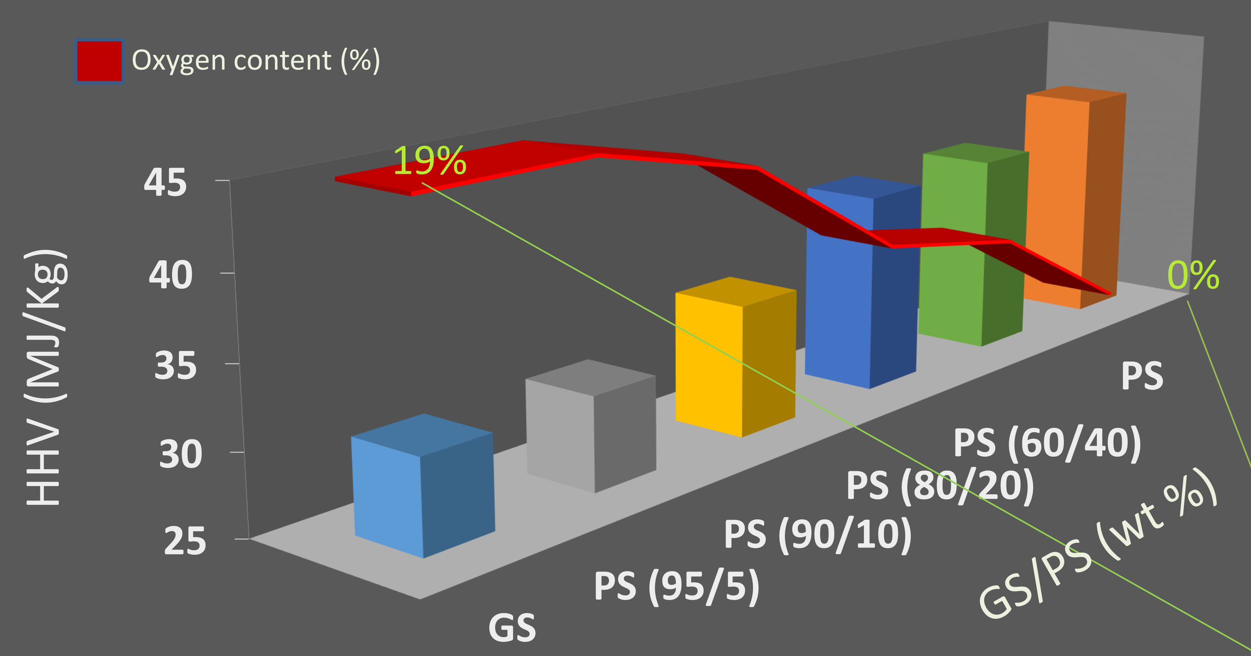


Figure 5. Evolution of HHV and the oxygen content of the bio-oil produced in the pyrolysis of GS and PS and the co-pyrolysis of GS/PS

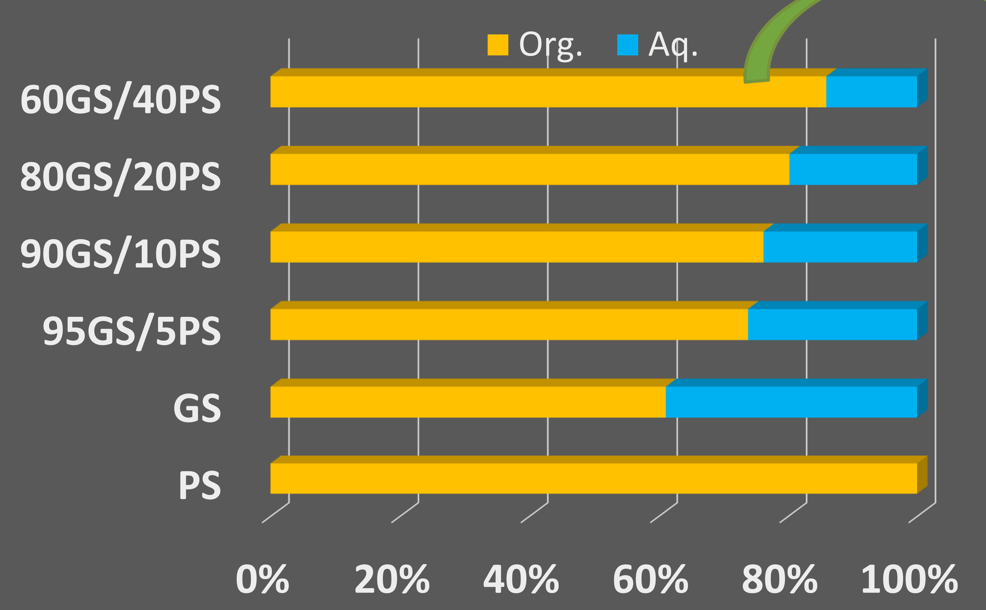


Figure 4. % organic phase and aqueous phase from co-pyrolysis of GS and PS

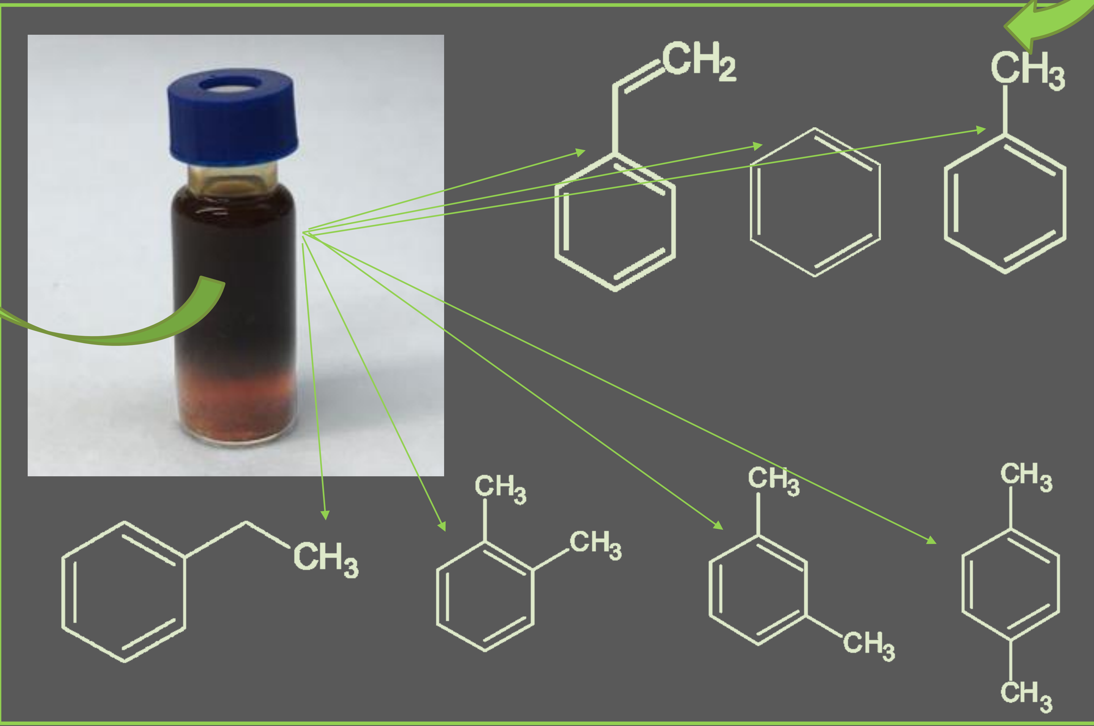


Figure 3. Bio-oil obtained from co-pyrolysis of GS and PS

SYNERGISTIC EFFECT

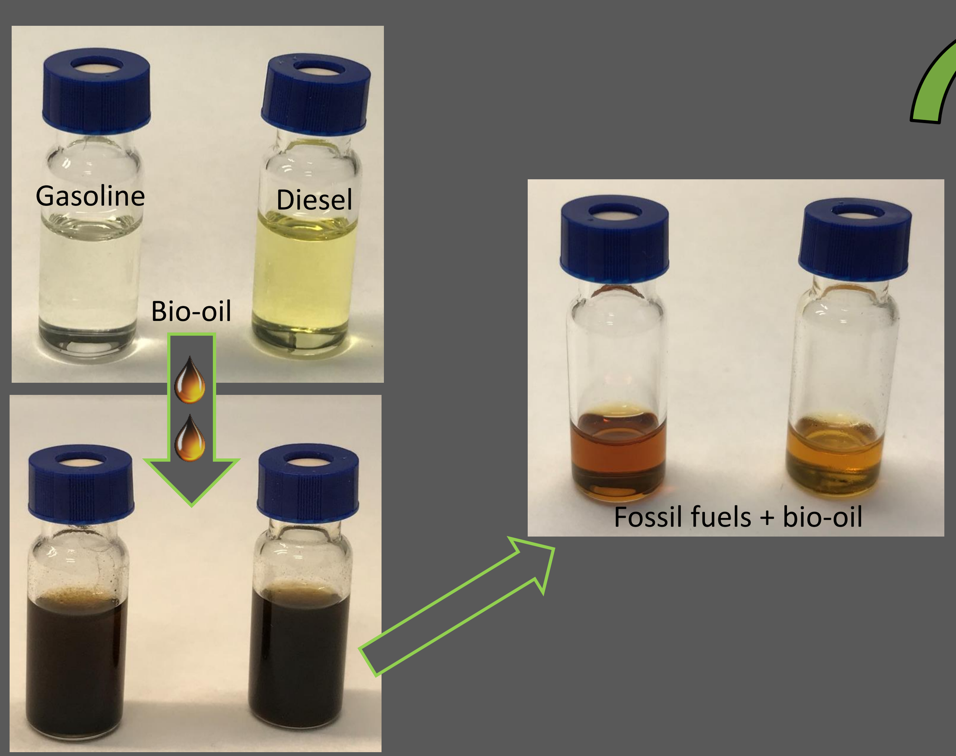


Figure 6. Increase of HHV with a decrease in the oxygen content of the bio-oil produced in the pyrolysis of GS and PS and the co-pyrolysis of GS/PS

APPLICATIONS

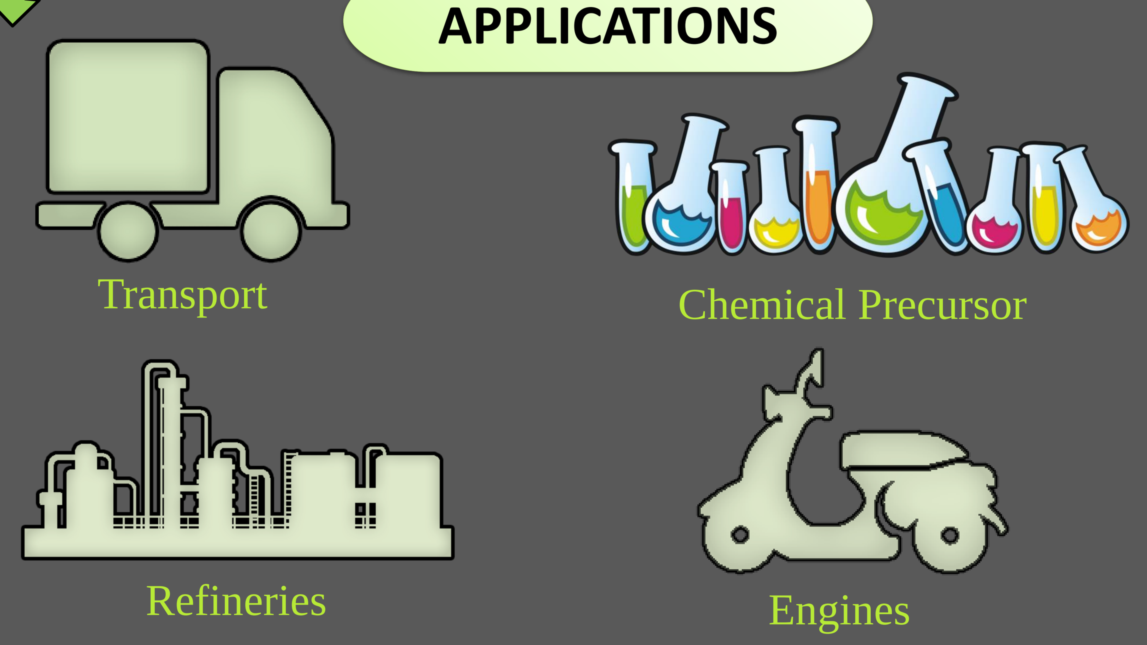


Figure 7. Examples of bio-oil applications

CONCLUSSIONS

The results achieved show the great potential of grapes seeds to carry out the catalytic co-pyrolysis process with different plastic residues in order to produce a liquid bio-oil that can be considered as a high quality renewable vector. Thus, optimizing the operational conditions to maximize liquid yield and improving the organic fraction properties are the next steps for the development of new generation bio-oils.

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